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Low Income System Key Assembly

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LOW INCOME SYSTEM KEY ASSEMBLY

By

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The most effective means of urban renewal for people with low income consists in the development of new communities in close proximity of large cities in relation with modern mass transportation preferably suspended. The ideal image of a new community is best realised by a progressive approach in solving sociological and economical problems without restriction of satisfactory urban performance. The new development should comprize a complex center with railroad terminus and around quiet housing section with large areas of green. Supposed 90,000 people would accomplish a comfortable life in a new development unit, about one hundred houses of convenient volume would be necessary for dwelling purpose alone. For buildings with different assignment one structural system could be used to reduce the cost of construction as well as to speed the development.

A new structural system called "Low Income System Key Assembly" is proposed and protected by a patent pending application to succesfully meet requirements for a huge housing program, matching a given schedule for time and economy. The proposed system discregards traditional transversal bearing walls and ascribes the bearing function to periphery walls offering complete freedom for any layout of interior space. The over all dimensions of the building are in accordance with requirements of the building code for dwelling purposes as governing objective however the interior may be used for schools, offices, department stores, halls for entertainment, or other facilities as well.

Referring to dwelling layout, the corridor system with apartments on both sides equally exposed to sunshine represents a good living standard and can be developed properly within 60'-0'' span. The optimal length comes out from two sidewing dwelling sections with a lobby between where elecators, stairs and other facilities are situated. Security measures limit one dwelling section to 120'-0'' and choosing the lobby 60'-0'' wide the building may extend up to 300'-0'' all main dimensions thus being a multiple of established module 12'-0'' which is proper dimension for a habitable room. The height of the building has certain practical and economical features. The sixteen story structure can be built with moderate dimensions of structural elements using only medium equipment for erection, but the system can be applied for buildings with twenty four stories, or higher. Evaluating the outlines space for a dwelling house a typical floor has a clear usable area 14,600 sf and the entire sixteen story building offers 232,000 sf which can easily accomodate as many as 900 people. See Tab III for architectural and structural layout.

The main features of the proposed structure is an assembly of periphery wall panels and integrated twin of floor panels posttensioned after erection, and pipe-bolt connection permitting large tolerance during erection and finally developing high friction shear resistance. The typical assembly is applied in both sidewings whereas the lobby section is grouped by means of standard elements and box shaft members for stairs and elevators. Assembly panels are 12'-0'' wide to match the module.

The standard wall panel applicable in both frontal and transversal walls extends over four floors and on ground level and underneath the roof is alternately followed by a two story high panel to acquire a staggering horizontal joint for erection without temporary bracing and for better rigidity of walls. The wall panel is developed as a chanel with continuous web columns and slab stiffened by transversal ribs for hinch supported floor panesl. The columns have constant section through sixteen stories being uninterrupted by floor structure and axially loaded only. Supporting ribs of wall are unflexible vertically and do not introduce any moment in columns. The bearing capacity of columns is controlled by reinforcement being increased gradually downward. On the top and bottom of columns and on the top of foundation wall there are rigid steel plates to which the reinforcement is welded. The plates have hole-pin connection in vertical axis for accurate placing of panels. After lining up and after applying dry pipe-bolt connection in vertical joints, the plates are welded on inside periphery and high strenth mortar is pushed into the joint by means injection pipe. The bearing capacity of filled joint corresponds to that of columns. The wall panel has openings for windows and doors. Detail of the all panel is on Tab. I.

The floor panel is an integrated twin of two unequal panels, one being developed as two modules in length, the other as three modules channel with the middle joint provided by pipe-bolt connection and posttensioned by lateral deflection of exposed tendons or stressteel bars. The shorter panel may be extended by cantilevered balcony slab. The cross section of the floor panel has a shape of two I-beams with top slab in between, and transversal ribs matching module patern. The webs are offset from the joint, helping to develop overhanging flanges at both top and bottom. Bottom flanges permit the introduction of final prestressing force at time of erection when only dead load of twin is available. Both panels of the twin are separately and fully prestressed by unbonded tendons in the range of first module. The panels of the twin are placed one by one on ribs of the wall panel and temporary supported underneath the middle joint. The optional balcony extension of shorter panel is pushed through the opening in the wall during erection. Webs of integrated twins are connected to ribs of the wall panel by pipe-bolt connection. Subsequently tendons or stressteel bars are attached along the webs following the bottoms of transversal ribs, and coupled to already prestressed bars on the face of first intermediate rib. Couplers on the opposite side work differently; one being able to turn on, the other with divergeant thread introduces a slight tension into the prestressing steel. The bars are then laterally contracted in the center span by means of a diversally threaded rod and powered impact to the extend when washers on anchorplates close to couplers become revealed. In that moment the full prestressing force is introduced into the section. The lateral force applied is about 15% of its working force. With respect to this fact and keeping the concrete section under slightly trapezoidal compression there is the easy possibility to adjust any time later the prestressing force and thereby to control and deflection without touching the lodging area, because the turning point of tendons is situated in the center of the corridor, and the coating of the ceiling can be easily removed. Regarding fireproofing of the ceiling, additionally, special coating may be applied by means of suspended fire clay stones.

The integrated twin is sensitive for deflection, and some precaution has to be taken to ensure proper behavior of floor structure. Unequal length of floor panels offers staggering middle joint for stiffening of borken webs, thus employing adjacent twins to counter local excessive deflection. Transversal ribs are welded in joint on the top and bottom and work as a subordinate bearing system with support on columns of transversal walls. The columns of transversal walls have an angle seat underneath the rib of the twin providing welded shear connection without introducing any moment into the columns or ribs, and thereby totally eliminate any deflection of the web along the transversal wall.

Pipe-bolt connection used in the assembly is a new connection

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permitting greater tolerance for erection during linging up of elements and develops strong friction shear resistance in the joint. The connecting bolt is pushed through the pipe of larger diameter embeded in concrete and probeded with an outward bent injection tube. The pipe is closed on outside end by a washer and the area of the joint is sealed by elastic rope on periphery. Adjacent surfaces of joint are grooved. High strength cement mortar or epoxy resin injected into pipe penetrates into the joint, rigid. See Tab II for detail of floor panel.

The stability of the structure is established by rigidity of walls, floors and shear resisting joints. The over all stability is critical in transversal walls when the structure is subjected to wind and earthquake forces. The overturning moment develops shear in vertical joints which are already taken care of and tension or compression on the edges of transversal walls. The columns provide ample capacity for compression, but horizontal joints are not strong enough to resist the tension. Therefore, Intersection columns are pottensioned; gradually along as erection is progressing, thus reducing excessive shear being introduced into frontal walls.

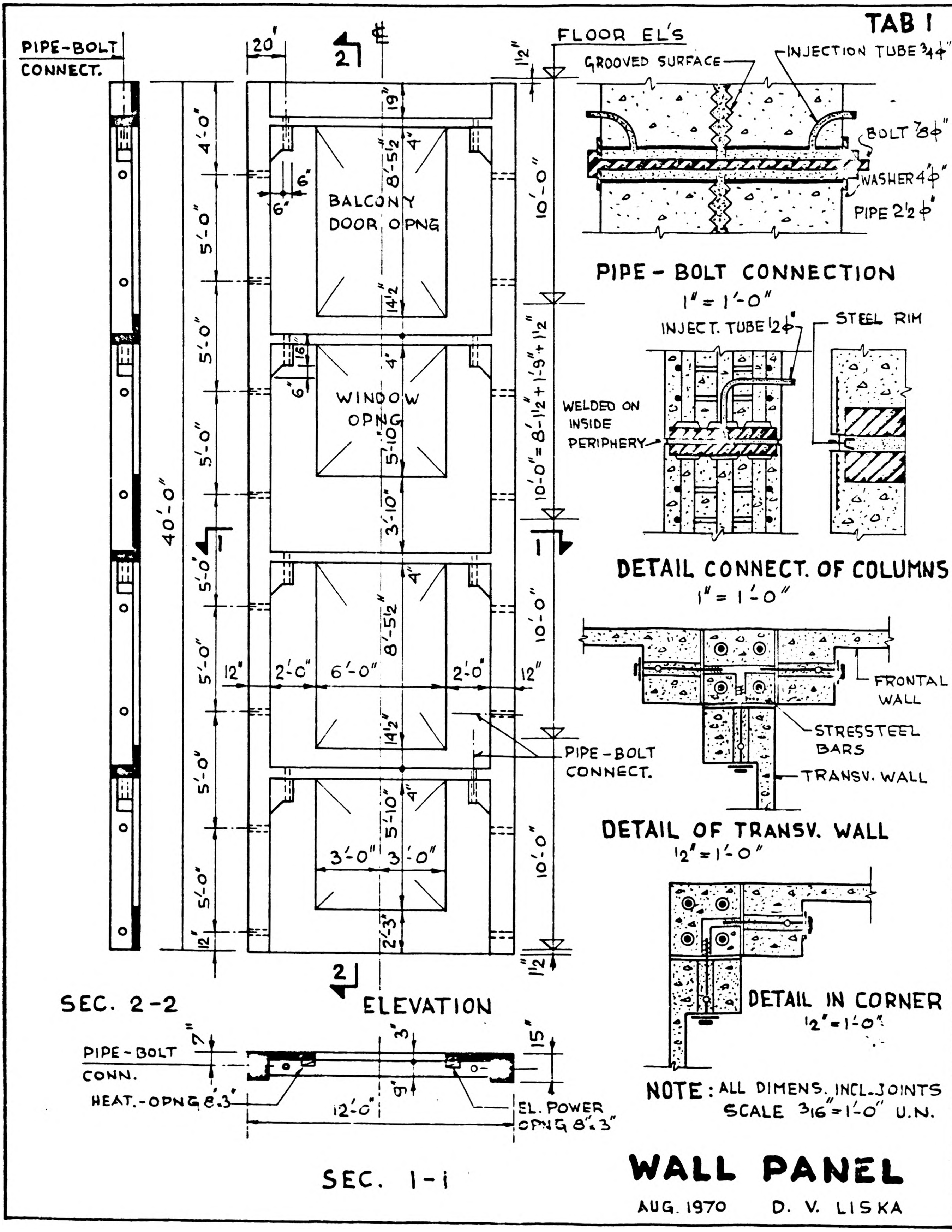
The foundation of the structure consists of continuous foundation walls sitting on cantilevered foundation slabs provided for frontal and transversal walls. The depth of the walls is a function of modulus of foundation, rigidity of the foundation wall and of simultaneously increased weight and stiffness of assemblied wall.

For the erection of sixteen story structure at least two cranes operating from outside are necessary to assemble the elements. Both sidewings can be erected simultaneously by using four cranes. The lobby section is grouped as a last one. The cranes used must be able to lift the hook 180'-0'' above the ground and operate 20 T on cantilever 30'-0''. The erection begins with all two story high columns posttensioned to foundation wall. The foregoing are the only elements to be temporaryly braced. Staggered wall panels are erected proceeding from fixed columns and after the periphery is closed twins of floor panels are placed in the entire area of sidewings using single telescoping temporary supports underneath webs in the middle joint. The floor is then posttensioned. After the second floor is erected in the same way one cyclus of assembly is completed. The further procedure becomes obvious.

Metal windows in concrete frames are placed with no great amount of delay. No special attention is necessary at this point. One particular advantage should be pointed out concerning the coating of the ceiling. The floor panel is so proportioned as to provide accurate space for standard plasterboards in between flanges of the twin. For partition only light double plaster boards are used, with the provision on ceiling allowing for possible differencial deflection of adjacent floors. See Tab. IV for preliminary estimate of concrete and time for erection.

The analysis showns one building requiring 400 hours for erection when two cranes are used. Setting up the construction schedule for a community of 100 houses approximately three years, at least 30 houses should be erected in one year. With 50 effective weeks in a year based on 40 working hours a week, one assembly group would be able to accomplish 50x40/400=5 houses a year, namely six groups operating simultaneously apart could meet the production requirements. This volume represents 30x8400/50x5=1000 cy of concrete to be poured a day or 1000x27x0.15/2=2000 T of precast elements to be delivered a day to the construction site.

It is obvious the economy aspects almost dictate the establishment of a factory for the mass production of the precast structural elements in the center of such a project thereby serving various areas of construction.


TAB I
PIPE-BOLT CONNECT.
FLOOR EL'S
GROOVED SURFACE
INJECTION TUBE ¾ϕ"
BOLT ⅞ϕ"
WASHER 4ϕ"
PIPE 2½ϕ"
PIPE - BOLT CONNECTION
1" = 1'-0"
BALCONY DOOR OPNG
WINDOW OPNG
40'-0"
10'-0" = 8'-1½" + 1'-9" + 1½"
INJECT. TUBE ½ϕ"
STEEL RIM
WELDED ON INSIDE PERIPHERY
DETAIL CONNECT. OF COLUMNS
1" = 1'-0"
FRONTAL WALL
STRESSTEEL BARS
TRANSV. WALL
PIPE-BOLT CONNECT.
DETAIL OF TRANSV. WALL
½" = 1'-0"
DETAIL IN CORNER
½" = 1'-0"
SEC. 2-2
ELEVATION
PIPE-BOLT CONN.
HEAT.-OPNG 8"·3"
12'-0"
EL. POWER OPNG 8"·3"
NOTE: ALL DIMENS. INCL. JOINTS
SCALE 3/16" = 1'-0" U.N.
SEC. 1-1
WALL PANEL
AUG. 1970
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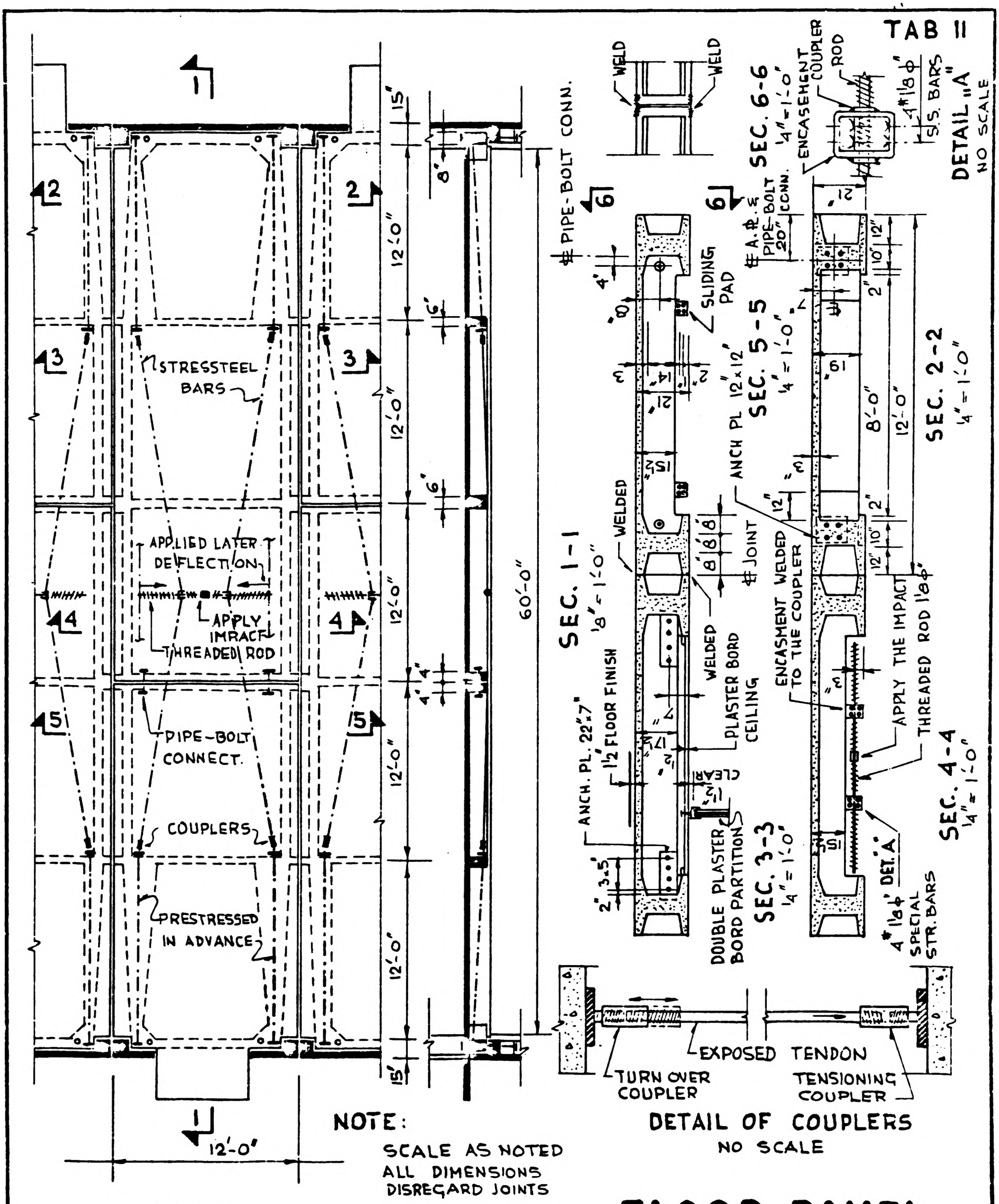

FLOOR PANEL

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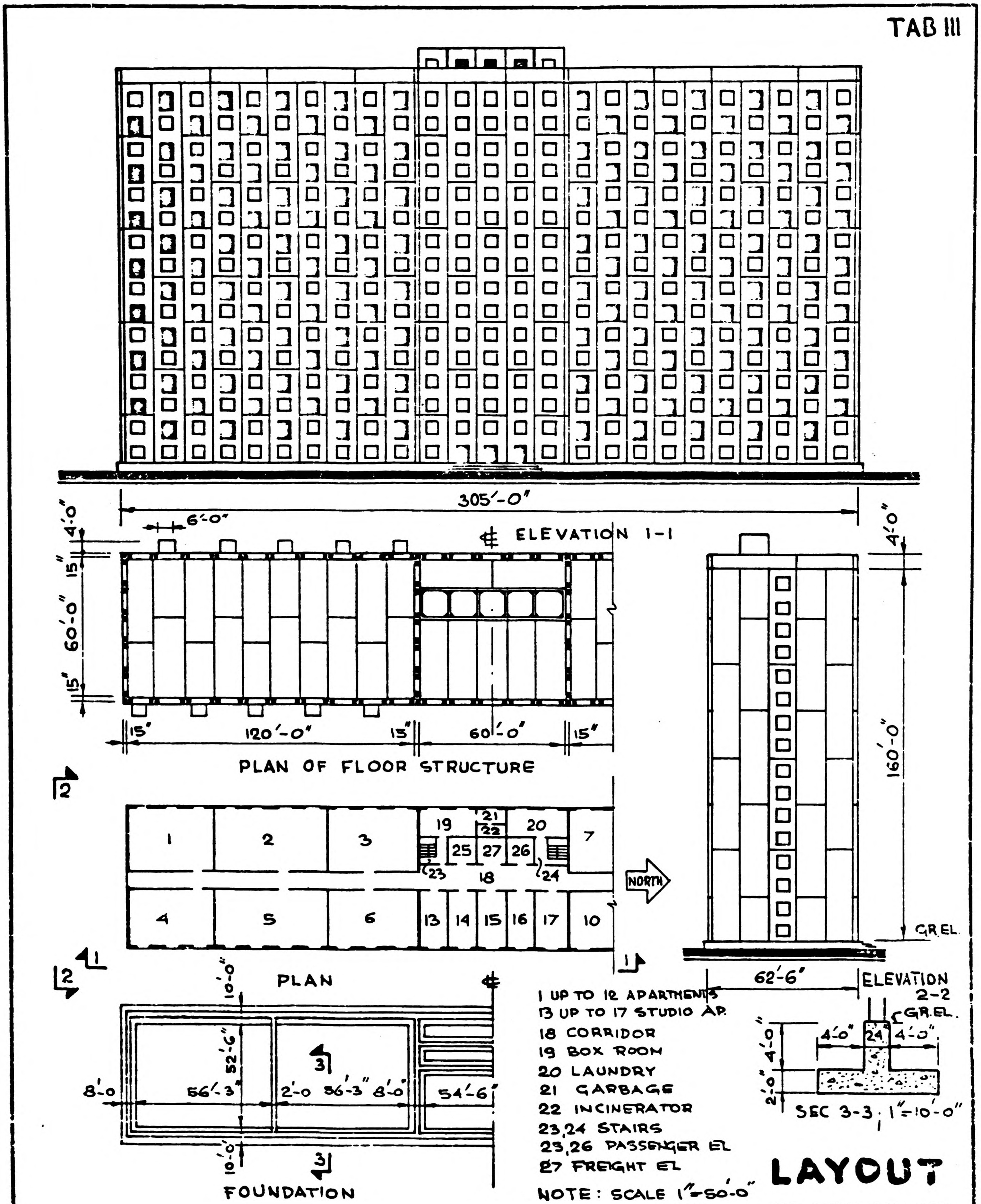
TAB III
305'-0"
6'-0"
ELEVATION 1-1
4'-0"
15"
60'-0"
15"
15"
120'-0"
15"
60'-0"
15"
PLAN OF FLOOR STRUCTURE
1
2
3
19
21
22
20
7
25
27
26
23
18
24
NORTH
4
5
6
13
14
15
16
17
10
PLAN
160'-0"
GR.EL.
62'-6"
ELEVATION 2-2
10'-0"
52'-6"
8'-0
56'-3"
2'-0
56'-3"
8'-0
54'-6"
10'-0
3
FOUNDATION
1 UP TO 12 APARTMENTS
13 UP TO 17 STUDIO AP.
18 CORRIDOR
19 BOX ROOM
20 LAUNDRY
21 GARBAGE
22 INCINERATOR
23,24 STAIRS
25,26 PASSENGER EL
27 FREIGHT EL
NOTE: SCALE 1"=50'-0" U.N.
GR.EL.
4'-0"
24
4'-0"
2'-0"
SEC 3-3 1"=10'-0"
LAYOUT
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TAB IV

LIST OF ELEMENTS FOR 16 STORY STRUCTURE							
		1	2	3	4	5	6*
1	WALL PANEL 4 FLOORS	246	184	13.8	1680	20	84
2	WALL PANEL 2 FLOORS	68	92	7.0	232	20	24
3	FLOOR PANEL 3 MOD	400	230	17.3	3420	20	133
4	FLOOR PANEL 2 MOD	320	159	12.0	1890	20	107
5	FLOOR PANEL 2½ MOD	32	85	5.6	220	15	8
6	SHAFT ELEV. BOX PANEL	48	200	15.0	356	20	16
7	STAIRS BOX PANEL	32	250	18.7	296	20	11
8	ROOF BOX PANEL	5	245	18.3	46	20	2
9	BALCONY INTEGR. WITH 4	300	12	0.9	133	—	—
10	COLUMN 2 FLOORS	16	32	2.4	19	10	3
11	COLUMN 4 FLOORS	24	64	4.8	57	10	4
12	ROOF COLUMN	8	6	0.5	2.0	10	2
13	ROOF WALL 3 MOD.	12	65	4.9	29	15	3
14	ROOF WALL 2 MOD	12	44	3.3	20	15	3
	TOTAL	1571			8,400		400

1. AMOUNT OF ELEMENTS
2. C.F. PER ONE ELEM.
3. TON PER ONE ELEM
4. Σ C.Y.
5. TIME OF ERECTION PER ONE ELEMENT IN MINUTES
6. Σ ERECTION TIME IN HOURS

SQUARE FOOT INDEX OF CONCRETE
0.74 C.F PER SQ.FOOT-FLOOR

CUBIC FOOT INDEX OF CONCRETE
0.074 C.F. PER ONE C.F.

LIST OF ELEMENTS

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